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BODY PROPORTIONS AND SEXUAL MATURATION

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Abstract

This study compared the body proportions of pre- and postmenarcheal girls of the same chronological age. The results are based on the data of relative longitudinal, transversal and circumference measurements representing the proportional differences and changes in the trunk and the limbs. The subgroups were compared by means of the Anova test; the multiple comparisons were tested by SCHEFFÉ's formula.

Analytical considerations revealed that there are significant differences in body shape between the earlier and later maturers. The length-breadth proportions of the chest and pelvic region differ significantly: premenarcheal girls have a more linear trunk. The menarche occurs earlier in those girls who have a more developed chest and broader hips in relation to the shoulder breadth, as well as a proportionally longer trunk and shorter extremities.

Key words: growth, body dimensions, body proportions, maturation, menarche.

Introduction

One of the stages of ontogenesis which is accompanied by the most dynamic changes is puberty, the intermediate stage between childhood and youth. In this stage of life, the growth of the bone and musculature systems and also the development of the reproductive organs become very intensive.

The intensive quantitative changes and the accelerated development of the sexual organs in this hormonally unbalanced age show up in great differences between children of the same sex but with different growth patterns.

A higher developmental level of the reproductive organs is indicated in menarcheal girls, but on the other hand the menarche indicates the end of the intensive growth of the bone and musculature systems (TANNER, 1961).

The differences between the absolute body measurements of postmenarcheal and premenarcheal girls of the same age indicate that during the maturation the growth processes are more intensive and faster in girls who mature earlier and therefore whose growth and development are finished earlier (FRISCH and REVELL, 1970; BODZSÁR, 1977, 1982; DANKER and BENTZ, 1982; FARKAS and SZEKERES, 1982; PÁPAI, 1996). Thus, it seems possible that differences can be found in the body proportions of children maturing earlier or later in spite of their having the same chronological age.

The purpose of this paper was to furnish data on the growth kinetics on the basis of some differences in body shape of pre- and postmenarcheal girls of the same chronological age.

Subjects and methods

The cross-sectional growth study was carried out in 23 settlements in the Bakony region in Western Hungary (BODZSÁR, 1991). The distribution of the pre- and postmenarcheal girls according to age groups is summarized in Table 1. The sample represents rural children living in a highly industrialized environment.

Table 1. Subjects.

Age (yr.)	Postmenarcheal girls	Premenarcheal girls
10.5	6	126
11.0	7	132
11.5	21	134
12.0	37	104
12.5	53	85
13.0	83	46
13.5	118	26
14.0	121	19
14.5	129	5

The absolute dimensions were measured with consideration to the internationally recognized standards of MARTIN and SALLER (1966) and the IBP recommendations (WEINER and LOURIE, 1969). Of these variables, 13 relative measurements and indices were calculated.

The differences between postmenarcheal and premenarcheal girls and also the successive age groups were studied by means of the two-way ANOVA test. In the pair-wise comparisons, SCHEFFÉ's contrasts were used to reveal significant differences (HAJTMAN, 1968).

Results and discussion

There are no statistically significant differences in the *length-breadth proportions* of the trunk in postmenarcheal girls of different ages, whereas in premenarcheal girls there are significant changes with age. The ratios of the biacromial breadth, the chest circumference and the biiliocristal breadth to the sitting height reveal that the premenarcheal girls have a more linear trunk. The smallest differences are to be found in the length-breadth proportions of the trunks of the postmenarcheal and premenarcheal girls in the shoulder region, whereas in the chest and pelvic region there are significant differences in every age group, premenarcheal girls having a more linear trunk (Table 2).

In the *proportions of the breadth measurements* of the three regions of the trunk, there are no significant changes with age in either postmenarcheal or in premenarcheal girls. At the same time, the ratio of the mesosternal breadth to the biacromial breadth and the ratio of the biiliocristal width to the biacromial breadth differ significantly in the postmenarcheal and premenarcheal girls (Table 3). The menarche occurs earlier in

girls who have a more developed chest and broader hips relative to the shoulder breadth.

Table 2. Length-breadth proportions of the trunk.

Premenarcheal girls				Postmenarcheal girls			
Mean	$s_{\bar{x}}$	S.D.	Age (yr.)	Mean	$s_{\bar{x}}$	S.D.	t-test, p <
Biacromial breadth/Sitting height (%)							
41.17	0.15	1.94	10.5	42.16	0.77	2.62	n.s.
41.71	0.18	2.27	11.0	42.34	0.66	2.30	n.s.
41.30	0.15	1.87	11.5	41.18	0.25	1.66	n.s.
41.10	0.17	1.90	12.0	41.58	0.29	1.77	n.s.
41.80	0.22	2.08	12.5	41.55	0.27	2.06	n.s.
42.03	0.26	1.86	13.0	41.79	0.23	2.11	n.s.
40.90	0.37	2.07	13.5	41.69	0.18	2.12	n.s.
40.83	0.45	1.97	14.0	41.24	0.21	2.40	n.s.
40.18	0.67	1.51	14.5	41.60	0.29	2.34	n.s.
Chest circumference/Sitting height (%)							
89.75	0.51	6.34	10.5	94.23	0.77	4.87	0.050
91.13	0.56	6.98	11.0	94.90	0.80	6.94	0.050
91.31	0.48	5.85	11.5	94.06	0.87	6.35	0.050
92.07	0.63	6.84	12.0	94.89	0.82	5.71	0.050
92.83	0.60	5.76	12.5	93.87	0.83	6.32	0.050
92.07	0.68	6.92	13.0	94.50	0.83	6.44	0.050
91.15	0.73	5.00	13.5	94.95	0.65	6.55	0.050
91.42	0.70	5.69	14.0	94.68	0.62	6.33	0.050
90.39	0.83	5.22	14.5	94.31	0.83	6.65	0.050
Biiliocristal width/Sitting height (%)							
29.91	0.20	2.59	10.5	31.44	0.42	2.20	0.050
30.43	0.17	2.10	11.0	32.12	0.48	1.46	0.050
30.59	0.18	2.33	11.5	31.59	0.40	2.03	0.050
30.92	0.18	2.00	12.0	31.60	0.28	1.74	0.050
30.54	0.24	2.32	12.5	31.32	0.35	2.62	0.050
30.25	0.28	1.99	13.0	31.74	0.28	2.63	0.050
30.76	0.47	2.59	13.5	31.91	0.20	2.36	0.050
30.36	0.44	2.39	14.0	31.81	0.20	2.33	0.050
29.85	0.62	1.59	14.5	32.20	0.26	2.05	0.050

The differences between the occurrence of the adolescent growth spurt in the different length measurements can be observed very clearly via the relative sitting height and the relative iliospinal height (Table 4). Analysis of the *proportions of the trunk extremities* demonstrated that postmenarcheal girls have a proportionally longer trunk and shorter extremities than premenarcheal girls, i.e. the occurrence of menarche is preceded by an intensive adolescent growth in sitting height.

There are no significant changes with age in the *proportions of the extremity lengths* (Table 5) in either the postmenarcheal or the premenarcheal girls and there are no differences in these proportions between matured and non-matured girls of the same age. This fact reveals that the lower and upper extremities undergo longitudinal growth in parallel. On the other hand, the postmenarcheal girls have broader and thicker lower and upper extremities in every age group than the premenarcheal girls.

Table 3. Breadth-breadth proportions of the trunk

Premenarcheal girls				Postmenarcheal girls			
Mean	$s_{\bar{x}}$	S.D.	Age (yr.)	Mean	$s_{\bar{x}}$	S.D.	t-test, $p <$
Mesosternal breadth/Biacromial breadth (%)							
69.07	0.34	4.28	10.5	72.18	0.71	4.45	0.050
69.12	0.32	3.98	11.0	71.89	0.56	4.14	0.050
69.24	0.36	4.41	11.5	70.65	0.70	4.42	0.050
69.24	0.33	3.69	12.0	70.60	0.71	4.43	0.050
69.58	0.38	3.60	12.5	70.83	0.51	3.88	0.050
69.70	0.63	4.50	13.0	71.22	0.56	5.21	0.050
69.33	0.63	3.45	13.5	71.47	0.36	4.15	0.050
69.72	0.74	3.66	14.0	71.57	0.44	4.94	0.050
68.86	0.75	3.03	14.5	71.22	0.55	4.41	0.050
Biiliocristal width/Biacromial breadth (%)							
72.78	0.50	6.21	10.5	74.63	0.76	4.80	0.050
73.45	0.41	5.20	11.0	75.96	0.85	4.05	0.050
73.72	0.41	4.97	11.5	75.23	0.86	4.72	0.050
73.48	0.37	4.10	12.0	75.89	0.77	4.68	0.001
73.22	0.57	5.43	12.5	75.43	0.74	5.56	0.001
74.37	0.52	4.74	13.0	76.10	0.78	5.21	0.050
74.37	0.56	5.47	13.5	76.60	0.44	5.12	0.050
74.97	0.67	4.69	14.0	77.15	0.50	5.78	0.050
74.29	0.62	3.98	14.5	77.59	0.71	5.61	0.050

Table 4. Proportions of the trunk extremities.

Premenarcheal girls				Postmenarcheal girls			
Mean	$s_{\bar{x}}$	S.D.	Age (yr.)	Mean	$s_{\bar{x}}$	S.D.	t-test, $p <$
Sitting height/Body height (%)							
51.51	0.10	1.25	10.5	52.19	0.41	1.49	0.050
51.51	0.10	1.24	11.0	52.28	0.35	1.98	0.050
51.71	0.11	1.38	11.5	52.05	0.24	1.24	0.050
51.45	0.12	1.38	12.0	52.88	0.21	1.31	0.050
51.43	0.14	1.36	12.5	52.33	0.18	1.39	0.005
51.42	0.20	1.41	13.0	52.24	0.15	1.40	0.050
51.50	0.25	1.38	13.5	52.14	0.12	1.47	0.050
51.30	0.30	1.24	14.0	52.32	0.12	1.40	0.050
51.74	0.34	1.29	14.5	52.05	0.16	1.33	n.s.
Iliospinal height/Body height (%)							
57.31	0.17	1.81	10.5	57.23	0.60	1.96	n.s.
58.01	0.14	1.83	11.0	57.05	0.31	1.83	0.050
58.10	0.14	1.72	11.5	57.29	0.32	1.64	0.050
58.32	0.15	1.83	12.0	58.07	0.24	1.50	n.s.
58.21	0.17	1.69	12.5	58.11	0.25	1.73	n.s.
58.48	0.19	1.77	13.0	58.30	0.23	2.12	n.s.
57.89	0.36	1.98	13.5	58.04	0.18	2.13	n.s.
58.24	0.46	1.92	14.0	58.00	0.18	2.10	n.s.
58.29	0.43	1.96	14.5	58.02	0.29	2.14	n.s.
Iliospinal height/Sitting height (%)							
110.48	0.41	5.11	10.5	109.80	0.74	5.73	n.s.
112.68	0.38	4.78	11.0	111.44	0.60	5.58	0.050
112.51	0.42	5.17	11.5	111.16	0.72	5.12	0.050
113.49	0.49	5.42	12.0	112.16	0.71	5.38	0.050
113.28	0.49	4.73	12.5	112.48	0.66	5.00	0.050
113.70	0.81	5.78	13.0	112.28	0.56	5.27	0.050
112.54	0.81	5.99	13.5	111.24	0.47	5.51	0.050
112.75	0.72	5.80	14.0	111.77	0.47	5.33	0.050
111.60	0.64	5.11	14.5	111.88	0.60	5.63	n.s.

Table 5. Proportions of the extremities.

Premenarcheal girls				Postmenarcheal girls			
Mean	$s_{\bar{x}}$	S.D.	Age (yr.)	Mean	$s_{\bar{x}}$	S.D.	t-test, $p <$
Upper extremity length/Iliospinal height (%)							
75.47	0.24	3.07	10.5	75.72	0.67	2.38	n.s.
75.26	0.23	2.93	11.0	75.76	0.65	2.72	n.s.
74.91	0.25	3.04	11.5	75.40	0.62	3.10	n.s.
75.05	0.29	3.16	12.0	75.75	0.50	3.14	n.s.
75.16	0.32	3.05	12.5	75.76	0.43	3.27	n.s.
75.71	0.62	3.37	13.0	75.52	0.40	3.76	n.s.
76.41	0.63	3.88	13.5	75.34	0.27	3.11	n.s.
76.08	0.61	3.44	14.0	75.75	0.32	3.64	n.s.
75.34	0.41	3.17	14.5	75.01	0.35	2.85	n.s.
Biepicondylar humerus/Upper extremity length (%)							
9.00	0.04	0.56	10.5	9.15	0.12	0.62	n.s.
8.99	0.04	0.54	11.0	9.15	0.10	0.47	n.s.
8.86	0.05	0.60	11.5	8.97	0.11	0.54	n.s.
8.80	0.05	0.61	12.0	8.86	0.10	0.65	n.s.
8.70	0.06	0.59	12.5	8.78	0.06	0.48	n.s.
8.72	0.12	0.66	13.0	8.79	0.06	0.63	n.s.
8.70	0.09	0.49	13.5	8.78	0.04	0.53	n.s.
8.58	0.11	0.48	14.0	8.77	0.05	0.61	n.s.
8.64	0.12	0.63	14.5	8.77	0.06	0.54	n.s.
Biepicondylar femur/Iliospinal height (%)							
10.35	0.05	0.63	10.5	10.40	0.10	0.50	n.s.
10.20	0.04	0.55	11.0	10.30	0.11	0.49	n.s.
10.16	0.05	0.65	11.5	10.23	0.10	0.53	n.s.
10.09	0.06	0.68	12.0	10.16	0.09	0.58	n.s.
10.03	0.06	0.59	12.5	10.15	0.09	0.68	n.s.
9.95	0.11	0.66	13.0	9.97	0.07	0.64	n.s.
9.88	0.09	0.65	13.5	9.96	0.06	0.63	n.s.
9.64	0.13	0.58	14.0	9.94	0.06	0.68	n.s.
9.67	0.11	0.57	14.5	9.92	0.07	0.64	n.s.
Upper arm circumference/Upper extremity length (%)							
32.13	0.31	3.84	10.5	33.88	0.46	2.62	n.s.
31.75	0.29	3.75	11.0	33.60	0.49	2.63	n.s.
31.72	0.33	3.96	11.5	33.07	0.47	2.87	n.s.
31.85	0.37	3.75	12.0	33.55	0.50	3.74	0.050
31.97	0.37	3.46	12.5	33.77	0.51	3.88	0.050
31.53	0.47	3.99	13.0	32.28	0.40	3.68	0.050
30.92	0.51	3.79	13.5	33.34	0.36	3.62	0.005
31.64	0.57	3.69	14.0	33.08	0.37	3.86	0.050
32.06	0.49	3.59	14.5	33.10	0.48	3.89	0.050
Thigh circumference /Upper extremity length (%)							
52.73	0.39	4.86	10.5	57.00	0.43	3.51	0.005
52.61	0.43	4.79	11.0	56.78	0.71	4.95	0.005
52.11	0.38	4.82	11.5	55.78	0.87	4.36	0.001
52.00	0.48	4.65	12.0	55.94	0.69	4.22	0.001
51.90	0.47	4.51	12.5	55.10	0.68	4.91	0.001
52.07	0.58	4.49	13.0	55.02	0.56	4.94	0.001
52.44	0.53	4.53	13.5	55.67	0.48	4.47	0.001
52.68	0.40	4.80	14.0	55.68	0.53	4.98	0.005
52.78	0.43	4.74	14.5	55.56	0.58	4.58	0.005

Conclusions

The interpretation of the proportional differences to be found in the body dimensions of postmenarcheal and premenarcheal girls can be approached from two directions.

The results clearly show that the different stages of ontogenesis can only be reached after certain quantitative increases. As the growth processes of the different body measurements are dependent, the whole process of growth is well organized and thus it seems very likely that the development of certain body proportions is required for a higher developmental stage to be obtained. The menarche occurs earlier in girls who can be characterized by a stumpy, more robust body shape.

Approaching the problem from the other direction, it can be stated that the reason why the postmenarcheal and premenarcheal girls of the same age differ in their body proportions is that the physique genetically influences the growth as well as the maturation processes: a certain physique predestines to an early, and another physique a late maturation.

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